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Phasic blood flow patterns in the common umbilical vein of fetal sheep during umbilical cord occlusion and the influence of autonomic nervous system blockade

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1 Introduction

After the entry of the ductus venosus with its well oxygenated blood into the inferior vena cava with its poorly oxygenated blood from the lower part of the fetal body, the blood flows do not mix evenly in the normoxemic fetus, but, rather a preferential streaming exists.

The implications of streaming of venous blood are important in the fetus with its special anatomic connections that allow mixing of well oxygenated umbilical venous blood with poorly oxygenated systemic venous blood. Streaming occurs in the thoracic inferior vena cava of fetal monkeys [1] and lambs [2].

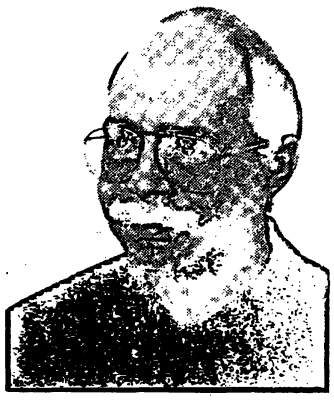
The umbilical venous blood flow from the thoracic inferior vena cava streams preferentially through the foramen ovale to the left atrium and left ventricle, whereas the poorly oxygenated distal inferior vena cava blood passes preferably through the tricuspid valve [2, 9].

The flow pattern in both superior and inferior venae cavae is pulsatile with two forward surges of blood flow during ventricular systole and diastole [10].

It has been shown by REUSS et al. [10] that changes in heart rate, ventricular afterload and the volumes of blood returning to the heart alter the pulsatile flow pattern in the venae cavae, thereby probably disrupting preferential streaming and enhancing mixing of ductus venosus blood with inferior vena cava blood.

It was suggested by them, based on only one observation in a single fetus, that factors which increased pulsatility in the fetal venae cavae might also influence the flow pattern in the common umbilical vein, which demonstrates no or only minimal pulsations under normal conditions. We observed pulsatile flow patterns in the common umbilical vein of fetal lambs

Curriculum vitae



TOM HASAART, *Ph. D.,was born in 1953 in Brunssum, the Netherlands. He studied medicine at the University of Amsterdam from which he graduated in 1978. He was registered as a specialist in obstetrics and gynecology in 1983. In 1984, he defended his Ph. D. thesis entitled: "Umbilical and uterine blood flow in pregnant sheep". He is currently working in the Department of Obstetrics and Gynecology of the State University Limburg in Maastricht. His principal interest in the field of perinatal research is the regulation of umbilical and uterine blood flow.*

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under various conditions [5], and this study deals with the phasic umbilical venous flow changes during cord occlusion.

2 Materials and methods

The experiments were carried out in eight pregnant sheep of the Dutch Texel breed. Surgical instrumentation was performed under aseptic conditions and under general anesthesia, induced with pentobarbital and continued with 5% halothane in a 2 : 1 mixture of nitrous oxide and oxygen. In the last third of pregnancy (term 146 days) the uterus was exposed through a paramedian abdominal incision. The fetal lambs were approached through a hysterotomy in the uterine wall lying over the fetal pelvis. They were provided with an inflatable balloon occluder around the total umbilical cord, an electromagnetic flow transducer around the intraabdominal common part of the umbilical veins and with catheters and electrodes for registration of arterial blood pressure (FBP), amniotic fluid pressure (IUP) and fetal heart rate (FHR). Fetal blood pressure was measured in the descending aorta. All catheters and electrodes were exteriorized through a stab incision in the ewe's flank and protected in a pouch attached to the ewe's skin. Umbilical blood flow (QUV) was measured with a Skalar Transflow 601 flowmeter system (Skalar, Delft, Holland). Fetal arterial blood pressure and amniotic fluid pressure were determined with pressure transducers with the zero point at the level of the ewe's spine.

All signals were amplified (Hewlett Packard 8800 series), displayed on a monitor and an eight-channel strip chart recorder and stored on magnetic tape.

Antibiotics (ampicillin 1000 mg) were administered intravenously to the ewe before operation and also infused (ampicillin 500 mg) in the amniotic cavity during surgery. For the first three days postoperatively the mother received procaine penicillin (2,000,000 IU) and dihydrostreptomycin (200 mg) intramuscularly.

The animals were allowed to recover for at least three days after surgery. Gestational age at the time of the experiments was 120 ± 2.5 days (mean ± SD; range 114–133 days). The cord occlusions were performed 7.6 ± 2.5 days (mean ± SD; range 3–26 days) after surgery.

All fetal variables were recorded for a control period of at least 30 minutes before experimentation was started. Total or partial compression of the umbilical cord was performed by slowly injecting sterile saline solution into the inflatable balloon around the umbilical cord.

The duration of the occlusion time varied between 20 and 90 seconds.

Selective blockade of the cholinergic, alpha-adrenergic and beta-adrenergic part of the autonomic nervous system was performed by administration of respectively atropine (1.0 mg/kg estimated fetal weight), phentolamine (2.5 mg/kg estimated fetal weight) and propranolol (1.0 mg/kg estimated fetal weight) to the fetus. All blocking drugs were administered via the indwelling femoral artery catheter in a bolus injection.

3 Results

3.1 Intact autonomic nervous system

Inflation of the balloon occluder around the total umbilical cord led to an increase in mean arterial blood pressure and a decrease in heart rate, phenomena which have been described extensively [3, 4, 6, 7, 8]. Umbilical venous blood flow abruptly decreased during cord occlusion and with complete inflation of the balloon, a total blockade of venous blood flow was accomplished.

The instantaneous flow pattern in the common umbilical vein which under steady-state conditions showed no pulsations, changed during cord occlusion to a pattern with biphasic pulsations in line with fetal heart rate (92 observations in 8 animals). This change occurred both in the situations in which umbilical venous blood flow was only partially reduced by incomplete inflation of the occluder as well as in

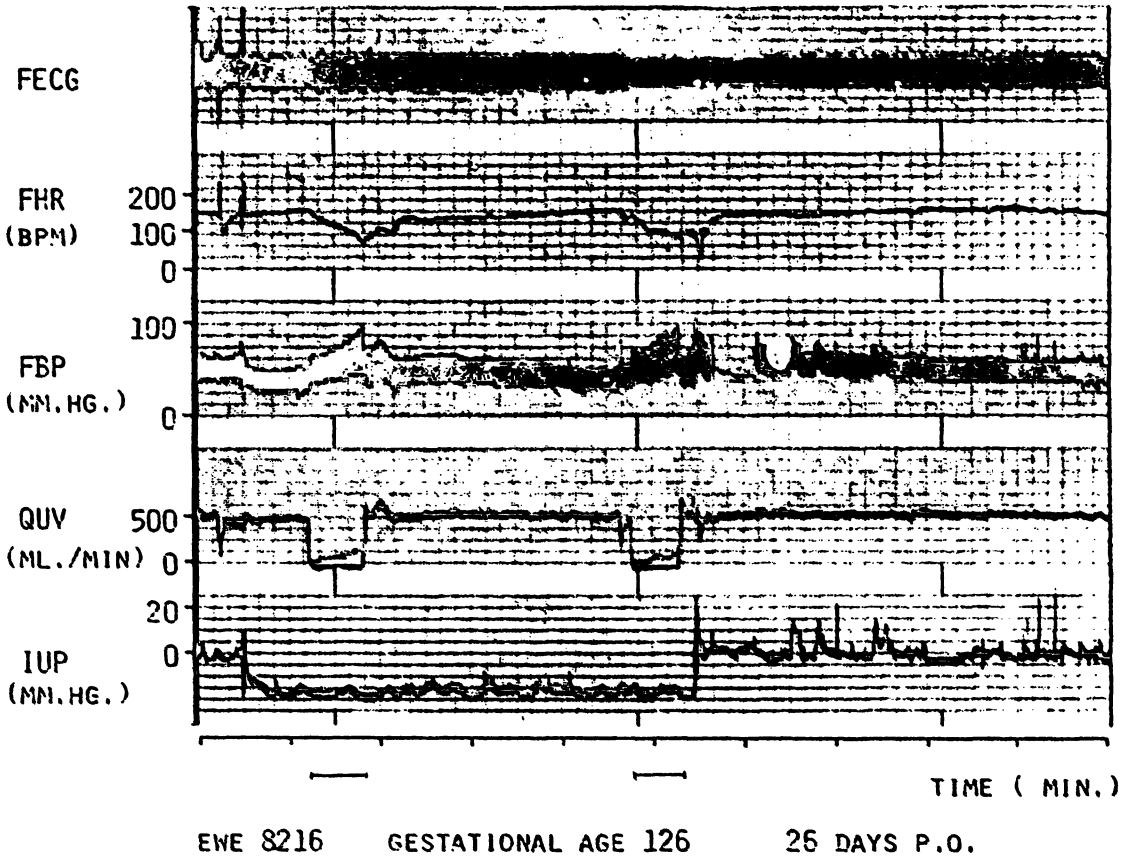

Figure 1. The occurence of pulsations in the phasic flow pattern of the common umbilical vein (|——| umbilical cord occlusion). The abrupt changes in IUP are caused by a postural change of the ewe.

those experiments in which a complete blockade of venous blood flow was established (figure 1). In the latter situation no mean forward flow was present of course, in contrast to the experiments with only partially reduced umbilical blood flow. The biphasic pulsations appeared after a certain delay after the beginning of the cord occlusion and gradually increased in amplitude to reach their maximum amplitude immediately before the end of the occlusion. Maximum pulsatility was seen with high blood pressure increases and deep bradycardia. An overshoot of umbilical venous blood flow was found after release of the cord occlusion. The pulsations disappeared after release of the cord occlusion or were abruptly diminished in size, in which latter case they were extinguished within several seconds after the occlusion, unless fetal bradycardia and hypertension were still pronounced at that time (figure 2).

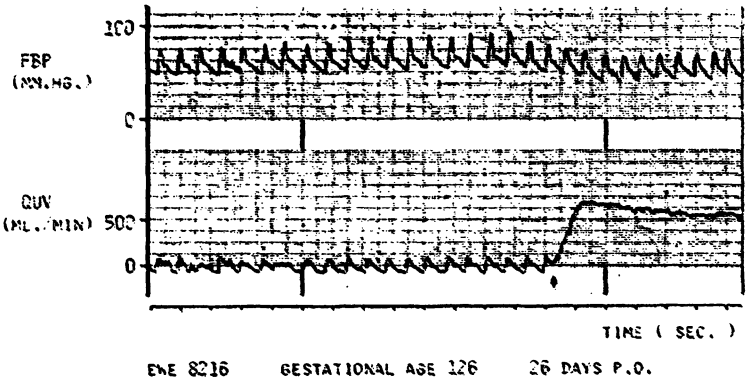

Figure 2. The occurrence of biphasic pulsations in line with fetal heart rate during umbilical cord occlusion (↑ end of the occlusion).

These venous pulsations were biphasic with a systolic component occurring during ventricular systole and a diastolic component during ventricular diastole. The systolic component started parallel with the arterial pressure rise, peaked and decreased again, after which a second diastolic flow "surge" was seen much smaller in amplitude and occurring during ventricular diastole. Thereafter a nadir occurred directly before the next rise in arterial blood

pressure. During this nadir retrograde flow occurred in the experiments with complete blockade of umbilical venous blood flow.

3.2 Selective blockade of the cholinergic, alpha-adrenergic and beta-adrenergic part of the autonomic nervous system

Cholinergic blockade with atropine (7 cord occlusions in 4 animals) prevented or diminished the fetal heart rate deceleration during the cord occlusion.

Fetal arterial blood pressure invariably increased during the occlusion with a gradually decrease to preocclusion values after the end of the occlusion.

Cholinergic blockade did not preclude the occurrence of biphasic pulsations in the common umbilical vein, but their shape was monophasic instead of biphasic (figure 3). The diastolic component of the pulsation disappeared then.

After alpha-adrenergic blockade with phentolamine (11 occlusions in 4 animals) an initial rise in arterial blood pressure was seen followed by a decrease in pressure during the latter part of the occlusion. Fetal heart rate decreased during the occlusion.

The magnitude of the venous pulsations during umbilical cord occlusions after alpha-adrenergic blockade did not differ from their appearance in the unblocked condition. With regard to the shape of the biphasic pulsation however a shift in the proportion of the systolic and diastolic component of the pulsation was observed during the latter part of the occlusion when arterial blood pressure decreased. The diastolic component of the pulsation increased in amplitude at the cost of the amplitude of the systolic component (figure 4). This change in pattern of flow was observed only during low arterial blood pressure.

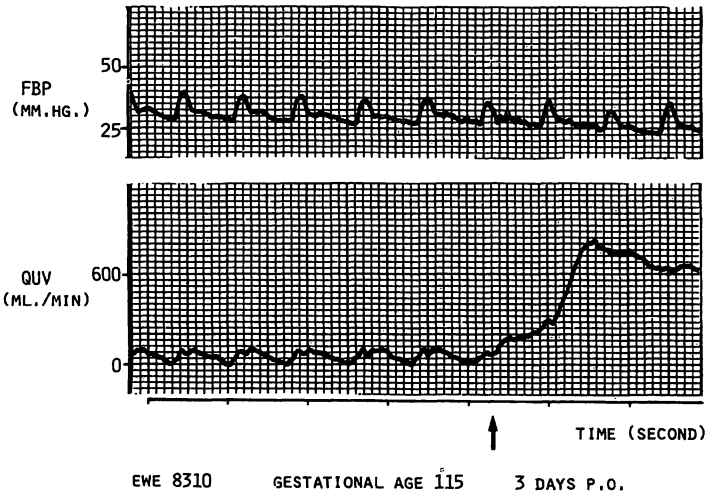

Figure 3. The occurrence of monophasic venous pulsations in line with fetal heart rate during umbilical cord occlusion after cholinergic blockade with atropine.

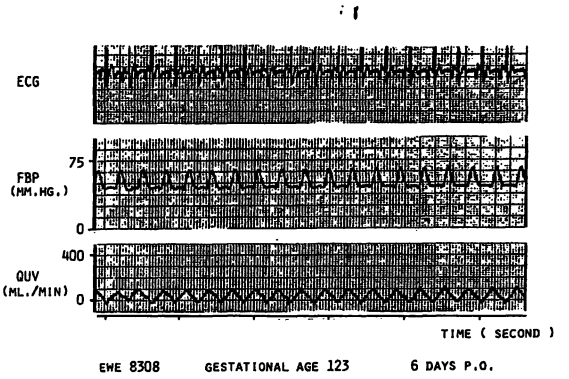

Figure 4. Biphasic pulsations in the common umbilical vein flow pattern at the end of an umbilical cord occlusion after alpha-adrenergic blockade with phentolamine. The diastolic component of the pulsation is more prominent than in figure 2. (↑ end of occlusion).

Umbilical cord occlusion during beta-adrenergic blockade (8 occlusions in 4 animals) resulted in fetal bradycardia and hypertension. Fetal arrhythmia with collapse of blood pressure often occurred in the latter part of the occlusion.

The pulsatile umbilical venous flow pattern during umbilical cord occlusion after beta-adrenergic blockade was the same in magnitude and shape as during cord occlusion in the fetuses with an intact autonomic nervous system.

4 Discussion

Under normal conditions biphasic pulsations in line with fetal heart rate are absent in the umbilical venous circulation of the sheep fetus. This is in contrast to the flow pattern in both venae cavae in the fetal sheep, in which vessels blood flow is always pulsatile, inversely related to venous pressure and influenced by the car-

diac cycle and respiratory movements [10]. These pulsations evidently are not large enough under normal circumstances to be propagated via the ductus venosus to the common umbilical vein.

During occlusion of the umbilical cord, there is an increased systemic arterial pressure and peripheral vascular resistance. Under normal circumstances this increase in afterload augments always present biphasic pulsations in the vena cava inferior to such a degree that they appear in the common umbilical vein after backward propagation via the ductus venosus.

The higher end-diastolic ventricular pressure associated with the increase in peripheral vascular resistance and arterial blood pressure leads to an increased ventricular contraction force, resulting in a higher systolic component in the vena caval flow surge [10]. This explains why the systolic component of the biphasic pulsation in the common umbilical vein is also greater than the diastolic component. The retrograde flow occurring with complete umbilical cord occlusion during the deep trough in between two biphasic pulsations was also found by REUSS et al. [10] for the flow pattern in the venae cavae during increased peripheral resistance and arterial blood pressure associated with fetal hypoxemia.

Forward flow in the venae cavae is normally impeded during atrial contraction. Conditions which result in an increase in arterial pressure as fetal bradycardia and increased ventricular afterload do, can eventually cause a retrograde flow in the venae cavae during atrial contraction. This flow pattern is then reflected in the common umbilical vein after backward propagation.

Cholinergic blockade prevented or diminished the heart rate deceleration associated with the umbilical cord occlusion. Higher heart rates shorten the diastolic filling time of the right atrium with a diminishing diastolic component of forward flow in the venae cavae as result. Biphasic caval flow becomes then monophasic [10] and the pulsations in the common umbilical vein follow this alteration.

Alpha-adrenergic blockade caused a blood pressure decrease in the latter part of the umbilical cord occlusion by preventing peripheral vasoconstriction.

This reduction in afterload allows for greater ventricular emptying and a decrease in end-diastolic pressure. A greater diastolic flow surge in the caval veins then occurs. This explains the relative increase in the diastolic flow component during the blood pressure decrease in the latter part of the umbilical cord occlusion after alpha-adrenergic blockade.

Beta-adrenergic blockade with propranolol did not essentially change the fetal heart rate and blood pressure responses during umbilical cord occlusion except for disturbances in rhythm.

No qualitative differences in the umbilical venous flow pattern changes during cord occlusions were observed compared with the unblocked condition.

Another possible explanation for the pulsatility of the flow signal in the absence of umbilical venous return during total cord occlusion might be that the pulsatile patterns are motion artifacts of the collapsed vessel and transducer together or of the transducer alone. Aortic pulsation and movement or movement of the diaphragmatic part of the thorax might be responsible for this phenomenon.

The fact that the pulsations also occurred when there was still umbilical venous flow in a distended vessel during partial occlusion of the cord makes the possibility of motion artifacts of the collapsed vessel very unlikely. It is concluded from these results that biphasic flow pulsations occur in the common umbilical vein during partial or total umbilical cord occlusion.

It is very likely that flow pulsations in the common umbilical vein and also in the ductus venosus can increase the degree of mixing of oxygen poor systemic inferior vena cava and oxygen rich placental ductus venosus blood; accordingly, this can interrupt preferential vena cava blood streaming leading to an alteration in the distribution of inferior vena cava blood in the fetal heart.

Summary

The blood flow pattern in the common umbilical vein is under normal conditions nonpulsatile in contrast to the flow in the fetal inferior vena cava. We observed pulsatile flow patterns in the common umbilical vein of fetal lambs during changes in the fetal hemodynamic equilibrium. These pulsations may influence the mixing of oxygen-rich ductus venosus blood and oxygen-poor inferior vena cava blood. This study deals with the phasic changes in umbilical venous blood flow during cord occlusion.

The experiments were performed in eight chronically instrumented fetal lambs between 114 and 133 days gestation (term 146 days). Umbilical venous blood flow was measured with an electromagnetic flow transducer around the intraabdominal common part of both umbilical veins. The fetuses were provided with catheter in the fetal abdominal aorta and with electrodes for monitoring arterial blood pressure and heart rate.

Occlusion of the umbilical cord was performed by means of an inflatable balloon occluder around the total cord (occlusion time 20 to 90 seconds). Occlusions were performed in fetuses with an intact autonomic nervous system and after blockade of the alpha-adrenergic, beta-adrenergic or cholinergic part of the autonomic nervous system.

Results: Fetal heart rate fell and arterial blood pressure rose during cord occlusion. The normally non-pulsative blood flow in the common umbilical vein changed to a flow pattern with biphasic pulsations in line with fetal heart rate during umbilical cord occlusion. The pulsations consisted of a systolic and a smaller diastolic component (figure 2). Cholinergic blockade with atropine prevented or diminished the fetal heart rate deceleration. The shape of the umbilical venous pulsations after cholinergic blockade was monophasic instead of biphasic. After alpha-adrenergic blockade with phentolamine a decrease in arterial blood pressure was observed during the latter part of the cord occlusion and the diastolic component of the biphasic umbilical venous pulsations increased then in amplitude. No changes in the shape of the venous pulsations during cord occlusions were observed after beta-adrenergic blockade with propranolol.

Discussion: Occlusion of the umbilical cord leads to an increased systemic arterial pressure and peripheral vascular resistance. This increase in afterload augments the under normal circumstances always present biphasic pulsations in the vena cava inferior to such a degree that they appear in the common umbilical vein after backward propagation via the ductus venosus. The changes in the biphasic venous flow pattern during cord occlusion, after cholinergic and alpha-adrenergic blockade, are caused by the concomitant changes in fetal heart rate and ventricular afterload. It is concluded that biphasic flow pulsations occur in the common umbilical vein during cord occlusion thereby probably increasing the degree of mixing of systemic inferior vena cava and placental ductus venosus blood.

Keywords: Autonomic nervous system blockade, umbilical cord occlusion, umbilical venous blood flow pattern, umbilical venous pulsations.

Zusammenfassung

Phasische Flow-Muster in der Umbilikalvene beim Schaffeten während Nabelschnurokklusion und Blockade des autonomen Nervensystems

Im Gegensatz zum Flow in der fetalen Vena cava inferior sind die Flow-Muster in der Umbilikalvene unter normalen Bedingungen nicht pulssynchron. Bei hämodynamischen Veränderungen konnten wir jedoch pulsabhängige Flow-Muster in der Umbilikalvene bei Schaffeten beobachten. Diese Pulsationen könnten die Mischung von O_2-reichem Blut aus dem Ductus venosus und O_2-armen Blut in der Vena cava inferior beeinflussen. In der vorliegenden Studie untersuchten wir phasische Veränderungen im umbilikalvenösen Flow während einer Nabelschnurokklusion.

Die Versuche wurden in 8 Schaffeten mit chronisch implantierten Kathetern zwischen dem 114. und 133. Tag der Tragzeit (gesamte Tragzeit 146 Tage) durchgeführt. Der umbilikalvenöse Flow wurde mit einem elektromagnetischen Transducer, der den intraabdominalen gemeinsamen Abschnitt beider Nabelvenen umschloß, gemessen. Den Feten wurden Katheter in die Aorta abdominalis sowie Elektroden zur Überwachung des arteriellen Drucks und der Herzfrequenz implantiert.

Die Nabelschnurokklusion wurde mit einem aufblasbaren Ballon, der die gesamte Nabelschnur umschloß, durchgeführt (Dauer zwischen 20 und 90 Sekunden). Das Abdrücken erfolgte bei intaktem autonomen Nervensystem sowie nach Blockade α-adrenerger, β-adrenerger oder cholinerger Rezeptoren.

Ergebnisse: Während der Nabelschnurokklusion erfolgte ein Anstieg des arteriellen Drucks und ein Abfall der Herzfrequenz. Der normalerweise nicht pulsierende Flow in der Umbilikalvene zeigte dann Muster mit biphasischen Pulsationen synchron zur Herzfrequenz. Die Pulsationen zeigten eine systolische und eine kleinere diastolische Komponente (Abb. 2). Eine cholinerge Blockade mit Atropin verhinderte oder schwächte Dezelerationen ab. Die Pulsationen in der Umbilikalvene waren dann nicht mehr bi-, sondern monophasisch. Nach α-adrenerger Blockade mit Phentolamin erfolgte

nach länger andauernder Okklusion ein Abfall des arteriellen Drucks. Die Amplitude der diastolischen Komponente bei den biphasischen Pulsationen stieg an. Nach β-adrenerger Blockade mit Propanolol zeigten sich bei Nabelschnurokklusion keine Veränderungen der Pulsationsmuster.
Diskussion: Die Okklusion der Nabelschnur führt zu einer Erhöhung des systemischen arteriellen Drucks und des peripheren Gefäßwiderstands. Dieser Anstieg des Afterload erhöht die unter normalen Umständen immer vorhandenen Pulsationen in der Vena cava inferior auf ein solches Maß, daß sie sich via Ductus venosus als Rückpulsationen in der Nabelvene auswirken.
Die Veränderungen der biphasischen Flow-Muster während der Nabelschnurokklusion nach cholinerger und α-adrenerger Blockade gehen einher mit Veränderungen der Herzfrequenz und des ventrikulären Afterload.
Wir schließen daraus, daß biphasische Flow-Muster, die bei Nabelschnurokklusion in der Umbilikalvene auftreten, Ausdruck einer erhöhten Durchmischung von Blut aus der Vena cava inferior und plazentarem Blut aus dem Ductus venosus sind.

Schlüsselwörter: Blockade des autonomen Nervensystems, Flow-Muster im Nabelvenenblut, Nabelschnurokklusion, Nabelvenenpulsationen.

Résumé

Types de flux sanguin phasique dans la veine ombilicale commune du fœtus d'agneau au cours de l'occlusion du cordon ombilical et l'influence du système nerveux autonome
Dans les conditions normales il y a dans la veine ombilicale commune un type de flux sanguin sans pulsations à l'inverse de ce qui se passe dans la veine cave inférieure du fœtus. Nous avons observé des séquences régulières dans la veine ombilicale commune des fœtus d'agneaux durant des changements de l'équilibre hémodynamique fœtal. Ces pulsations pourraient avoir une influence sur le mélange de sang riche en oxygène du ductus venosus et le sang pauvre en oxygène de la veine cave inférieure. L'étude porte sur les changements de phase dans le sang ombilical veineux pendant l'occlusion du cordon ombilical. Huit fœtus d'agneaux âgés de 114 à 133 jours (à terme à 146 jours) continuellement surveillés par des instruments ont fait l'objet des expériences. Un débimètre à champ magnétique mesurait la circulation ombilicale autour de la partie commune des veines ombilicales au niveau de leur jonction intra-abdominale. Les fœtus ont été pourvus d'une sonde dans l'aorte abdominale et d'électrodes afin de mesurer la tension artérielle et la fréquence cardiaque. L'occlusion du cordon ombilical était obtenue à l'aide d'un anneau gonflable placé tout autour du cordon (période d'occlusion de 20 à 90 secondes). Les occlusions ont été provoquées d'abord sur les fœtus sans atteinte du système nerveux autonome et ensuite après blocage de la partie alpha-adrénergique, beta-adrénergique ou cholinergique du système nerveux autonome.
Résultats: Durant les occlusions ombilicales il y a une baisse de la fréquence cardiaque fœtale et une hausse de la tension artérielle. Le flux sanguin de la veine ombilicale commune normalement non pulsatile se transforme durant l'occlusion ombilicale en séquence régulière avec des pulsations biphasiques tout comme la fréquence cardiaque fœtale. Le blocage cholinergique à l'aide d'atropine empêche ou diminue la décélération de la fréquence cardiaque fœtale. L'aspect biphasique des pulsations de la veine ombilicale commune est devenu monphasique après blocage cholinergique. Après blocage alpha-adrénergique à l'aide de phentolamine une baisse de la tension artérielle est constatée durant la dernière phase de l'occlusion ombilicale; par contre la composante diastolique des pulsations veneuses biphasiques s'amplifie. Nous n'avons constaté aucun changement dans l'aspect des pulsations veneuses durant l'occlusion ombilicale après blocage tu type beta-adrénergique à l'aide de propranolol.
Conclusions: L'occlusion du cordon ombilical provique une hausse de la tension artérielle et des résistances vasculaires périphériques. Cette hausse en «post-charge» (pression intra-ventriculaire gauche durant la systole isotonique) stimule les pulsations biphasiques toujours présentes dans la veine cave inférieure dans des conditions normales, à tel point qu'elles se manifestent dans la veine ombilicale commune à la suite d'une propagation rétrograde passant par le ductus venosus. Les changements dans l'aspect du flux veineux biphasique durant les occlusions ombilicales après blocage cholinergique et alpha-adrénergique sont causés par des changements simultanés de la fréquence cardiaque fœtale et de la «post-charge» ventriculaire. Nous pouvons conclure que la présence des pulsations biphasiques du flux dans la veine ombilicale commune pendant l'occlusion stimule problement le mélange du sang venant de la veine cave inférieure de la circulation systémique et le sang placentaire venant du ductus venosus.

Mots-clés: Blocage du système nerveux autonome, occlusions du cordon ombilical, pulsations de la veine ombilicale commune, séquence régulière dans l'enregistrement du flux sanguin dans la veine ombilicale commune.

References

[1] Behrman, R. E., M. H. Lees, E. N. Peterson, C. W. Delannoy, A. E. Seeds: Distribution of the circulation in the normal and asphyxiated fetal primate. Am. J. Obstet. Gynecol. 108 (1970) 956

[2] Edelstone, D. I., A. M. Rudolph: Preferential streaming of ductus venosus blood to the brain and heart in fetal lambs. Am. J. Physiol. 237 (1979) H 724

[3] Evers, J. L. H., J. de Haan, H. W. Jongsma, A. J. Crevels, T. H. M. Arts, C. B. Martin jr.: The preejection period of the fetal cardiac cycle. I. Umbilical cord occlusion. Eur. J. Obstet. Gynaecol. Reprod. Biol. 11 (1981) 401

[4] de Haan, J., C. B. Martin, J. L. H. Evers, H. W. Jongsma: Pathophysiologic mechanisms underlying fetal heart rate patterns. In: Thalhammer, O., K. Baumgarten, A. Pollak (eds.): Perinatal Medicine. George Thieme Publishers, Stuttgart 1979

[5] Hasaart, T. H. M.. J. de Haan: Blood flow patterns in the common umbilical vein in fetal sheep. In: Gennser, G. (ed.): Abstracts tenth conference on fetal breathing movements and other fetal measurements. Malmö, Sweden 1983

[6] Itskovitz, J., E. F. La Gamma, A. M. Rudolph: The effect of reducing umbilical blood flow on fetal oxygenation. Am. J. Obstet. Gynecol. 145 (1983) 813

[7] Künzel, W., L. I. Mann, A. Bhakthavathsalan, J. Ayromlooi, M. Liu: The effect of umbilical vein occlusion on fetal oxygenation, cardiovascular parameters, and electroencephalogram. Am. J. Obstet. Gynecol. 128 (1977) 201

[8] Mueller-Heubach, E., A. F. Battelli: Variable heart rate decelerations and transcutaneous pO2 during umbilical cord occlusion in fetal monkeys. Am. J. Obstet. Gynecol. 144 (1982) 796

[9] Reuss, M. L., A. M. Rudolph, M. A. Heymann: Selective distribution of microspheres injected into the umbilical veins and inferior venae cavae of fetal sheep. Am. J. Obstet. Gynecol. 141 (1981) 427

[10] Reuss, M. L., A. M. Rudolph, M. W. Dae: Phasic blood flow patterns in the superior and inferior venae cavae and umbilical vein of fetal sheep. Am. J. Obstet. Gynecol. 145 (1983) 70

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